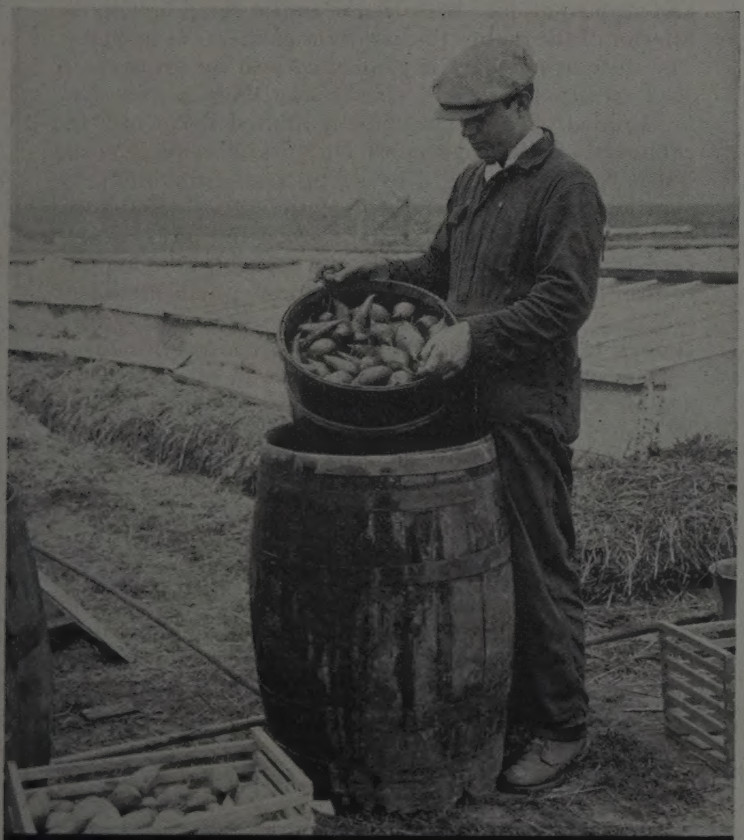
SWEETPOTATO *Diseases*



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SWEETPOTATOES in the field are affected by widespread and serious diseases such as stem rot, black rot, and foot rot, for which the only feasible control measures are selection of seed stock, the use of clean seedbeds, disinfection of seed stock before it is bedded, and crop rotation. Because the causal fungi invade the interior of the plants, the use of fungicides is of no value. The disfiguring scurf is controlled best by using clean seed sweetpotatoes and disinfecting them before they are bedded. The geographically limited Texas root rot cannot be eliminated because it occurs on so many hosts, but it can be decreased by deep, clean cultivation, by aeration of the soil, by the application of stable manure, and by rotation with resistant crops like grasses and cereals. For mottle necrosis and soil rot, no adequate control is yet known; the very common phyllosticta leaf blight, septoria leaf spot, and white rust are not serious enough to warrant the application of control measures.

When black rot, foot rot, and certain other diseases are not eliminated in the field, they are carried to the storage house, where they continue to spread. Stem rot, which does not produce any marked decay in storage, may open the way for the entrance of various decay-producing organisms. All the decay-producing organisms except the black rot fungus need wounds to cause infection. Keeping sweetpotatoes sound in storage depends largely on storing disease-free, well-cured roots in thoroughly disinfected houses kept at a temperature of about 55° F. and a relative humidity of about 80 to 85 percent.

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SWEETPOTATO DISEASES

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SWEETPOTATOES, one of the principal food crops of the Southern States, had a total production of about 72,679,000 bushels in 1939, with a value of approximately $74,900,000. It was estimated that field diseases reduced the yield by 3,209,000 bushels and storage rots reduced the supply by about 3,417,000 bushels more. Some organisms cause only field diseases, some storage diseases, and a few both. The field diseases reduce yield, affect the quality, and cause roughness, poor color, and poor shape. Some of the organisms that affect the growing plants, as well as others that cause decay of the roots in storage and marketing, produce great waste and at the same time have a bad influence on the market.

Black rot, both a field and storage disease which gives sweetpotatoes a bitter taste when cooked, probably causes as much loss as all the other diseases combined. Were it not for the losses caused by this and other field diseases and the decay caused by soft and ring rots and other storage diseases, more sweetpotatoes would be available to the consumer and for a longer period of time. The supply of sound sweetpotatoes does not depend alone on successful storage, but it depends partially on the control of field diseases, some of which are also destructive storage diseases. If black rot alone could be eradicated or even effectively controlled, the losses in storage would be greatly reduced.

CLASSIFICATION AND BRIEF DESCRIPTION OF SWEETPOTATO DISEASES

Field diseases:

Stem rot (wilt). Discoloration of the young leaves and vascular bundles of the stem; wilting of the vines (p. 2).

Black rot. Blackish, more or less circular, somewhat sunken spots on the underground parts of plant; eventual rotting-off of stem (p. 7).

Foot rot. Small, brown to black spots eventually girdling the stem near the soil line; wilting of the plant (p. 9).

Scurf. Brownish, superficial discoloration, or rusting, of the skin of sweetpotatoes; usually in spots (p. 11).

Root rot (Texas root rot). Firm brown rot of sweetpotatoes; vines invaded 6 to 12 inches above ground (p. 12).

Mottle necrosis. Brownish, somewhat shrunken irregular spots on enlarged roots; a marbled chocolate-brown discoloration of the interior (p. 14).

Soil rot. Dwarfing of plants; black spots on rootlets; jagged pits of various sizes on fleshy roots (p. 15).

Phyllosticta leaf blight. Angular or circular, brownish spots on the leaf with many black specks (p. 17).

Septoria leaf spot. Small, circular, whitish spots on the leaf with one or more black specks (p. 18).

White rust. Whitish, more or less powdery, sometimes slimy, growth on the under side of leaf (p. 18).

Storage rots:

Soft rot (ring rot). Soft, watery decay of sweetpotatoes (p. 19).

Black rot. Black, somewhat sunken spots on the sweetpotatoes, variable in size and form, sometimes penetrating a half inch (p. 20).

Surface rot. Circular spots; shallow rot; sweetpotato sometimes becoming hard and mummified (p. 21).

Dry rot. A firm brown rot of sweetpotatoes, eventually becoming dry, hard, and mummified (p 22).

Java black rot. A firm rot rendering sweetpotatoes dry, hard, and brittle, and coal black inside (p. 23).

Charcoal rot. A black rot characterized by production of minute spherical bodies through the sweetpotato (p. 24).

FIELD DISEASES AND THEIR CONTROL

STEM ROT (WILT, BLUE STEM, YELLOW BLIGHT)

Description

The first indication of stem rot in the field is a slight change in the appearance of the youngest leaves, which become duller in color and then yellowed between the veins and somewhat puckered. These symptoms are followed by wilting of the vines and eventually by a collapse and death of the entire plant (fig. 1). The vinelike stems of diseased plants are eventually darkened inside. This discoloration of the vascular bundles sometimes extends 3 to 5 feet from the hill and is a sure sign of stem rot. The fungus causing stem rot may also invade the fleshy roots, forming a blackened ring about a quarter of an inch below the surface (fig. 2). Sprouts from such sweetpotatoes are likely to be diseased.

In the hotbed the symptoms of this disease are similar to those in the field. Diseased plants can generally be detected by the faint purplish tint that is cast through the white part of the stem and by the yellow discoloration of the leaves.

FIGURE 1.—A sweetpotato plant showing the characteristic symptoms of stem rot.

Control

Fertilizers and Fungicides Ineffective

As the fungus causing stem rot invades the interior of the plant, the application of fungicides has never reduced the incidence of the disease. Lime and gypsum applied to the soil are of no control value.

Immune and Susceptible Varieties

The following varieties, none of which are entirely immune, can be grown with comparative safety in infested soil: White Yam, Southern Queen, Triumph, Red Brazil, Yellow Strasburg, Key West, and Dahomey. The following varieties are very susceptible to stem rot: Yellow Jersey, Big-Stem Jersey, Gold Skin, Nancy Hall, Porto Rico, Red Jersey, Georgia, Nancy Gold, Kansas 40, and Maryland Golden.

Seed Selection and Treatment

The causal fungus overwinters in sweetpotatoes in the storage house and grows from diseased seed stock into the plants developed from them. Slightly diseased plants are hard to detect, and, in consequence, many of them are set in the field, where the fungus continues to grow. It is, therefore, imperative that only healthy sweetpotatoes be used for the production of plants.

Healthy seed stock can be obtained by selection in the fall at digging time, while the sweetpotatoes are still attached to the vines. Each hill should be tested by splitting the stems. Sweetpotatoes for seed

FIGURE 2.—A section through a sweetpotato, showing the blackened ring just below the surface caused by the stem rot fungus.

should be taken only from plants with stems not streaked inside with black. Sometimes a heavy frost will also cause a darkening of the stem. The fall selection of seed stock is necessary, owing to the fact that in the spring or during the winter it is difficult and frequently impossible to tell whether the sweetpotatoes are diseased, since after a period in storage the bundles (the tissues traversing the root) of healthy sweetpotatoes often become somewhat darkened, even though the stem rot fungus is not present.

The sweetpotatoes selected for seed should be stored in baskets or crates, in a part of the house where they will not come in contact with the general stock.

In the spring just before the roots are bedded, they should be disinfected by treating them for 8 to 10 minutes in a solution made by dissolving 1 ounce of corrosive sublimate (mercuric chloride) in 8 gallons of water. Only wooden vessels should be used for disinfection (see cover illustration). The addition of 5½ pounds of wettable sulfur to 24 gallons of this solution increases its effectiveness. This treatment will not kill the stem rot fungus within the sweetpotato, but it will destroy any spores that may be on the surface. After about 10 bushels have been treated in 24 gallons of solution, one-half ounce of corrosive sublimate dissolved in hot water should be added and the solution made up to the original volume by the addition of water. Repeat the process after the treatment of each 10 bushels until 30 bushels are treated, then throw away the solution and start with a fresh one.

If corrosive sublimate cannot be used, the sweetpotatoes may be immersed for 5 minutes in a solution of formaldehyde made by adding 1 pint of commercial formalin to 30 gallons of water. Also if corrosive sublimate cannot be obtained, the seed sweetpotatoes may be disinfected by immersing them for 5 minutes in 2- to 2½-percent solution of borax. They should be bedded immediately after treatment. A solution of approximately this concentration may be prepared by dissolving 5 pounds of borax in 30 gallons of water. Borax can usually be purchased at the grocery store. The disinfecting quality of the borax is not reduced by repeated use. However, when the volume of the solution becomes too small to cover the sweetpotatoes more of the solution should be added.

Excessive amounts of boron are injurious to plants; therefore do not pour the unused portion of the borax solution on land to be used for crop production. Corrosive sublimate is very poisonous. Any sweetpotatoes treated with either corrosive sub-

limate or borax should never be fed to animals or used as food. The chemicals and the solutions remaining after treatment with them should be carefully disposed of or kept out of reach of children and animals. Formaldehyde also should be handled with care, as it is irritating to the skin.

Preparation of Hotbed

The repeated use of the same soil year after year in the hotbed is probably one of the chief means of distributing many sweetpotato diseases. This soil, after the hotbed season is over, is often either left in the beds or thrown out to one side with all the decayed sweetpotatoes and manure. The disease-producing organisms multiply, and if the same soil is used the next year the roots and plants are at once exposed to infection. Furthermore, when bedding their sweetpotatoes, farmers frequently throw the diseased ones to one side. These eventually become mixed with the soil, and the disease germs are carried on the shoes and by chickens and other agents to the hotbed. As a result hotbeds which might otherwise produce healthy plants become badly infected.

Soil once used in the hotbed should be hauled away, and all the rubbish around the bed raked up and carted off or burned. The framework of the hotbed and the ground around it should be thoroughly soaked with a solution of formaldehyde made by mixing 1 pint of commercial formalin and 30 gallons of water or, if preferred, with a solution of copper sulfate made by dissolving 1 pound of copper sulfate in 25 gallons of water. It is advisable that this treatment be repeated after about 24 hours. The soil for the hotbed, or preferably sand, should be obtained from some place where sweetpotatoes have never been grown, if possible from a high spot in the woods. The upper 6 inches of the soil should be thrown away and only subsoil used. Rich soil is not necessary for the hotbed; in fact, some of the best results have been obtained by using pure sand. The farm implements used to handle and haul away the old soil should not be used to handle new soil or sand without being cleaned and disinfected by a solution of formaldehyde. A grade of sand or subsoil that will not bake or form a crust through which the sprouts cannot emerge should be used.

In regions where sweetpotato diseases occur, the use of stable manure in the hotbed is a practice of doubtful value, since sweetpotatoes discarded or fed to stock find their way too easily to the manure pile. However, stable manure may be safely used if great care is exercised to cook all decayed or diseased sweetpotatoes before feeding them to stock and never to throw them out in the yard, where infected parts may be carried around on the feet of poultry and farm animals.

Crop Rotation

Although healthy plants may be grown by careful seed selection and care in the preparation of the hotbed, the effort is largely wasted if the plants are set in infested soil. It is, therefore, imperative that the plants be set on new ground or ground which has not produced sweetpotatoes for several years.

The stem rot fungus will live in the soil indefinitely, even in the absence of sweetpotatoes. For that reason, sweetpotatoes should not be planted on the same ground oftener than once in 3 or 4 years. The fungus will not be eradicated, but the losses will be reduced. No other crop except tobacco is known to be attacked by this fungus; therefore, any crops commonly grown in the region may be used in the rotation.

Slip Seeding

The practice of cutting sweetpotato vines into sections so as to include at least two buds or leaves and inserting one end, usually the larger, into the ground is known as slip seeding; the sweetpotatoes produced are used for seed for the next year's crop. The practice of slip seeding is followed generally in some localities and not at all in others. When intelligently done it is an efficacious means of controlling sweetpotato diseases. However, if practiced independently of all sanitary measures it is of little value. The author has examined quantities of slip-seed stock, both in the field and in storage, and found an abundance of stem rot, black rot, foot rot, and practically all of the diseases present in that particular locality. In regions where the disease germs are not present in all soils beneficial results have been obtained.

Precautions in slip seeding.—To obtain good results from slip seeding the following precautions must be taken:

1. The cuttings should be made from healthy vines. This will seem obvious when it is remembered that the organism causing stem rot often grows out into the vines 3 to 5 feet from the hill and its presence cannot always be detected without pinching open the vine.
2. The cuttings must be planted on new ground or on ground on which sweetpotatoes have not been grown for at least 6 years.
3. The sweetpotatoes produced by the cuttings must be picked over and disinfected in the spring before they are bedded, according to directions already given.
4. The seed stock must be bedded in a hotbed prepared according to the directions given on page 5.

Distribution, Prevalence, and Loss

Stem rot probably occurs more or less in every State where sweetpotatoes are grown. It is their worst field disease and the most difficult to control.

In New Jersey 10 to 50 percent of the crop may be destroyed by stem rot each year, and fields have been found where 95 percent of the plants were killed. In New Jersey and Delaware, where the sweetpotato forms an important money crop, the losses annually amount to many thousands of dollars. Conditions have been equally bad in Iowa, in parts of Kansas, and in southern Illinois. Although the losses in Maryland, Virginia, and Alabama are considerable each year, they are relatively less than in some other States. At the most conservative estimate, stem rot is responsible for a loss of at least three-quarters of a million dollars annually to the sweetpotato crop in the United States.

Means of Distribution

The stem rot fungus will overwinter in the soil on the remains of dead sweetpotato vines and in the roots in storage. Therefore, the distribution of the disease from one field to another in the same locality may be brought about by (1) insects, (2) farm animals that roam from

one field to another, (3) farm implements used in cultivation, (4) drainage water, (5) wind, and (6) discarded diseased roots dumped on the fields as fertilizer, either before or after being fed to stock.

The distribution of the disease from one locality to another is brought about primarily by the exchange or sale of seed sweetpotatoes and plants. In some cases the appearance of the disease in a locality can be definitely traced to such importation.

Cause

Stem rot is caused by a fungus (a moldlike plant) known as *Fusarium oxysporum* f. *batatas*. This organism, like many others of its kind, can live for several years on decayed vegetation in the soil until it again comes in contact with the sweetpotato.

Infection takes place through the roots, either in the field after the plants are set out or in the hotbed by growing from diseased seed stock into the plants. When set in the fields such infected plants soon die.

The mycelium, or vegetative part, of the fungus develops rapidly and often enters the root and grows up into the water-carrying vessels of the stem. After death the vines turn black, the fungus living thereafter on the decaying vegetation. On the dead vines numerous fruiting bodies, or spores, are developed. Being very small, the spores are readily carried by the wind, insects, and other agencies to other fields, where new infections may arise.

BLACK ROT (BLACK SHANK, BLACK ROOT)

Description

Black rot may occur on any of the underground parts of the plant. On the sweetpotato the causal fungus produces dark to nearly black, somewhat sunken, more or less circular spots on the surface (fig. 3). When young these spots are small and nearly round, but under favorable conditions they enlarge, until frequently they involve nearly the whole sweetpotato. Often in the center of the spots will be seen more or less circular areas, one-fourth to one-half an inch in diameter, in which may be found fruiting bodies of the causal fungus. The surface of the diseased spot has a somewhat metallic luster, and the tissue just beneath is greenish.

On the plants the infection begins as small black spots, which gradually enlarge until the whole stem is rotted off. Frequently it extends up the stem to the surface of the soil (fig. 4). It is important to remember that if sweetpotatoes affected by black rot are used for seed the plants coming from them will likely have the disease.

All growers are well aware that sweetpotatoes affected by black rot have a very disagreeable taste when cooked. Their sale has a bad effect upon the market, and they may be the means of carrying the disease into a locality where it has not occurred before.

Control

No varieties are known to be resistant to black rot.

Black rot is easy to control by following methods already known. About the same control methods should be applied to it as to stem rot, particularly the preparation of the hotbed, the selection and treat-

ment of disease-free seed sweetpotatoes, and crop rotation. If black rot alone is concerned, the seed may be selected in the spring instead of in the fall; if selected in the fall, it should be picked over again in the spring just before it is bedded and any sweetpotatoes with suspicious spots on them should be discarded.

FIGURE 3.—A sweetpotato showing a black circular spot produced by the black rot fungus. Such spots are somewhat sunken.

FIGURE 4.—A small sweetpotato plant showing the characteristic blackening of the underground part of the stem caused by the black rot fungus.

The treatment of the soil with sulfur, lime, gypsum, or various fertilizers has little effect on the disease. Dipping the slips in a solution of bordeaux mixture or in a lime-sulfur mixture just before they are set in the field may reduce the incidence of the disease but does not prevent it entirely and has been found to injure the plants.

Distribution, Prevalence, and Loss

Black rot occurs in most of the States where sweetpotatoes are grown. The disease is prevalent on the plants or slips in the hotbed,

in the field, and on the roots in the storage houses in the winter; in fact, heavy losses are caused by this disease in storage houses, where it spreads and develops freely under favorable conditions and renders the sweetpotatoes unfit for consumption.

Means of Distribution

In general, black rot is disseminated in about the same way as stem rot. Unlike stem rot, however, black rot spreads freely through the storage house under favorable conditions. Mice and small flies and other insects carry the spores on their bodies from diseased to healthy sweetpotatoes, where, if conditions are favorable, new infections take place. Distribution in the storage house may also be brought about by the handling of roots when they are picked over and prepared for the market or by settling in the bins. Washing the sweetpotatoes may distribute the germs from one potato to another.

Cause

Black rot is caused by a fungus (*Ceratostomella fimbriata*). It is a disease of the underground parts of the plant. Infection takes place through the roots, either coming from the soil after the plants are set in the field or by growing on the plants in the hotbed from diseased stock used for seed. Plants diseased so early in their life soon die, rarely producing any sweetpotatoes. This fungus, like many others of its kind, lives from one year to another on the dead vines or other decayed vegetable matter in the soil until it comes in contact with a sweetpotato plant. No other host plants are known.

FOOT ROT (DIE OFF)

Description

Foot rot appears first as small brown to black spots on the stem of the plant near the soil line. The growth of the causal fungus is very slow at first, but eventually it girdles the plant and extends up the stem 4 or 5 inches. Soon thereafter wilting of the plant begins, and round, black, rather numerous specks, just visible to the naked eye, appear in the diseased areas (fig. 5). These specks are the fruiting bodies of the fungus causing the disease. This disease progresses rather slowly, and it is about midsummer or later before the plants begin to die off. In most instances no sweetpotatoes are found in the affected hills, though long vines may have been produced.

The organism causing foot rot may spread from an infected stem to the roots and cause a brown, rather firm rot of the sweetpotato. Later, fruiting bodies standing close together develop on the surface in the form of pimplelike protuberances (fig. 6). Many wounds and bruises on sweetpotatoes in storage are infected with the foot rot fungus.

Control

Some of the same control measures should be employed for foot rot as for stem and black rots, namely, seed selection, the use of clean seedbeds, seed treatment, and crop rotation.

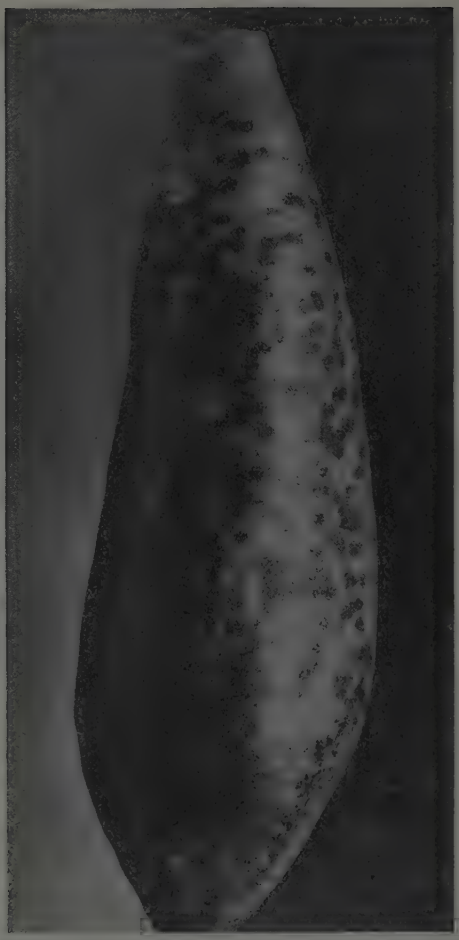

FIGURE 7.—A sweetpotato showing discoloration caused by the scurf fungus.

actual financial loss throughout the country that can be attributed to this disease alone is considerable. Scurfy sweetpotatoes do not command as high a price in the market as clean ones, though if otherwise sound they are just as good for food.

Scurf, under favorable conditions, such as a relatively high humidity and temperature, continues to develop under storage conditions to a limited degree. It may damage the sweetpotato skin, so that during periods when the storage house is rather dry the root loses moisture and becomes shriveled and dried.

Cause

Scurf is caused by a fungus (*Monilochaetes infuscans*). This organism lives through the winter on the crop in storage and on the decayed vines in the field. If infected sweetpotatoes are used for seed, the fungus grows on the plants and is carried by them to the field. The organism produces no apparent injury to the plants in the hotbed or in the field, but it continues its growth and follows down the roots to the sweetpotatoes. It will live for a considerable time on decayed vegetable matter in the soil in the absence of the sweetpotato.

ROOT ROT (TEXAS ROOT ROT)

Description

Root rot is known best on cotton and alfalfa. The organism causing this disease gains access to the underground parts of sweetpotato plants and spreads in both directions, invading the vines for 6 to 12

inches above ground. It may enter the end of the sweetpotato or may cause spots of varying sizes on the surface. In either case a firm brown rot is produced, resulting in the complete destruction of the sweetpotato (fig. 8). Above ground the growth is within the stem and may be detected by the brown discoloration produced.

FIGURE 8.—A sweetpotato showing the characteristic shriveling produced by the root rot fungus.

Control

Root rot is worse on black, poorly drained soil and during wet seasons. The disease is particularly difficult to control or eradicate because it occurs on a great variety of plants. Deep, clean cultivation, aeration of the soil, application of stable manure, and crop rotation, together with the careful selection of disease-free sweetpotatoes for seed, should be employed. Though the fungus attacks a great variety of plants, both wild and cultivated, grasses, corn, and other cereals are partially or completely immune and should be used in the rotation.

Distribution, Prevalence, and Loss

Texas root rot has been reported to occur in Texas, New Mexico, Oklahoma, Arizona, California, Arkansas, and Nevada. When the disease once gets into a field a whole crop may be destroyed. Large fields have been seen in which not more than 10 percent of a crop was produced. Viewed from a distance, the field looked promising, but when harvested the sweetpotatoes were nearly all found to be destroyed by the fungus.

The causal organism lives from one season to the next in the soil on dead vegetable matter and probably on growing winter crops and weeds. It is killed by hard freezing, and this alone probably restricts the disease to the Southern States. The disease may occasionally be observed as early as May or June, but it is in August that it becomes really serious. By this time the vines are well developed and the sweetpotatoes of considerable size. From this time on the disease increases in severity, so that by September and October, when the roots are dug, a large percentage of the crop may be found to be destroyed. It may occur in spots of various sizes. Not all hills and not all the sweetpotatoes in a hill are necessarily destroyed.

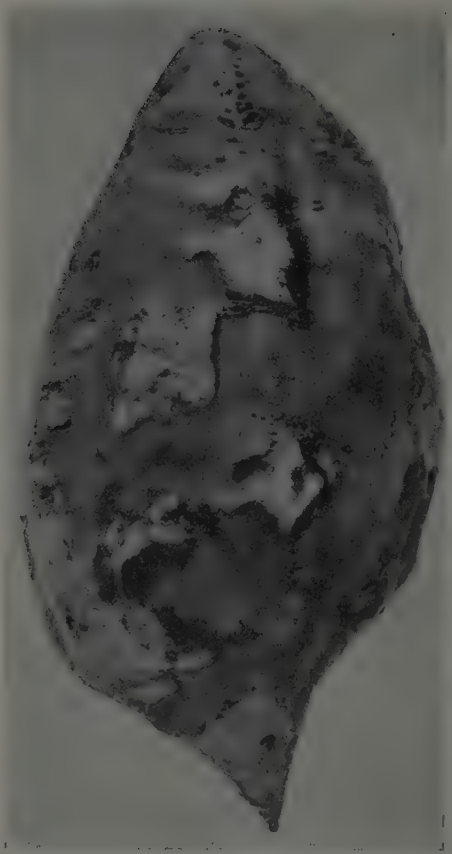

FIGURE 9.—A sweetpotato with a large part of the surface brown and somewhat sunken, a condition characteristic of the advanced stage of mottle necrosis.

Cause

Root rot is caused by a fungus (*Phymatotrichum omnivorum*) which presumably lives from one season to the next by means of the brown hyphae and possibly spores. The mycelia or hyphae are produced on the surface of the roots in the form of grayish wefts or strands, which can be easily recognized with a hand lens by one familiar with the organism.

MOTTLE NECROSIS

Description

Mottle necrosis, a field disease of the enlarged roots, is characterized externally by brownish, somewhat sunken spots, which are noticeably irregular in shape and size (fig. 9). Usually the sweetpotato remains more or less firm. The most striking symptom of the disease is revealed by cutting the root crosswise through one of the brown, sunken surface spots. In cross section the disease is characterized by irregularly shaped patches of chocolate-brown dead tissue (fig. 10). The dead patches frequently appear to have no connection with one another, giving in cross section a marbled appearance. The entire sweetpotato may be involved even though there is but a small spot of disease tissue on the surface.

Control

No method for the control of mottle necrosis has been worked out. The disease is worst during seasons that have abundant rainfall and in soils that are fairly light and sandy, although some infection may

occur in fairly heavy soils. The most susceptible varieties are Triumph, Yellow Jersey, Big-Stem Jersey, and Georgia. Occasionally other varieties may be slightly infected. Susceptible varieties should not be planted in soils where mottle necrosis has been prevalent.

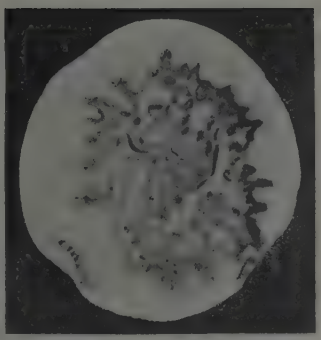

FIGURE 10.—A cross section through a sweetpotato showing the characteristic mottling of mottle necrosis. The causal organism may enter through a small rootlet and ramify to all parts of the sweetpotato.

Distribution, Prevalence, and Loss

Mottle necrosis occurs in New Jersey, Delaware, Virginia, North Carolina, Mississippi, and other States. The loss varies from year to year, depending upon soil and weather conditions, and on the varieties grown. The entire loss throughout the country is relatively small, but in certain isolated districts where such varieties as the Yellow Jersey are grown losses as high as 40 percent of the crop have occurred during the seasons especially favorable to the disease.

Cause

Mottle necrosis is caused by two fungi (*Pythium ultimum* and *P. sclerotcichum*). They probably gain entrance to the enlarged roots through the small fibrous roots attached. These small rootlets first become diseased and from them the large roots become infected.

SOIL ROT (POX, GROUND ROT)

Description

Soil rot produces symptoms markedly different from those caused by any other sweetpotato disease. In a heavily infested soil the plants are dwarfed and often produce only one or two short vines. The leaves are small, thin, and pale green. The above-ground symptoms are the result of injury to the root caused by an organism that may attack any part of the underground portion of the plant. The lateral feeding, or fibrous, roots may be few in number and often more or less malformed. On the feeding roots, as well as on the underground part of the stem, occur nearly black flecks, or spots, of various sizes and appearances. The decayed spots may occur on one side, or the root may be girdled, thereby cutting off the food supply. In the early stages of soil rot the lesions seem to be covered by the skin of the sweetpotato, which later ruptures, leaving conspicuous holes or pits. On the swollen roots (fig. 11) the pits often attain a diameter of one-half inch or more, with a jagged margin. The enlarged root is sometimes girdled; the sweetpotato continues to enlarge on each side of the point of infection and thereby produces a curious disfiguration crudely resembling a dumbbell.

FIGURE 11.—A sweetpotato showing typical soil rot pits. The pits may be large or small and may occur on any of the underground parts of the plant.

Control

No adequate control measure is known for soil rot. Some results of recent years indicate that the application of from 200 to 400 pounds of sulfur per acre will reduce the amount of soil rot and increase the yield. The application of sulfur should be made with considerable care as injury to the first and succeeding crops might result. The sulfur should be applied broadcast and thoroughly incorporated into the soil 2 to 4 weeks before the seedlings are set out.

Crop rotation and the improvement of the soil by the use of stable manure and green-manure crops can be recommended. Although the best of the commercial varieties are not immune to soil rot, there appears to be some varietal differences in susceptibility. It is not unlikely that a good commercial strain may be produced eventually

Growers must guard against the introduction of the causal organism into new fields and new localities. Cattle or other livestock can carry the germs on their feet, and should not be allowed to roam from infested to disease-free fields. Plows and various farm implements should be thoroughly cleaned after they are used to cultivate infested fields before they are taken into clean fields. If plants are purchased from outside sources, be sure they are free of soil rot.

Distribution, Prevalence, and Loss

Soil rot occurs more or less generally throughout the sweetpotato belt. It occurs in California; in some, if not all, of the Southern States; in New Jersey, Delaware, Maryland, Virginia, Iowa, Kan-

sas, and Illinois, and in practically all the Northern States where sweetpotatoes are grown. Recently it has become a limiting factor in crop production in Louisiana. The disease does not occur generally throughout a State but is more or less localized. It may be bad in one field or locality and absent in another only a few miles away.

While no figures can be given of the loss caused by soil rot, it may be estimated to be from practically nothing to almost complete failure. The losses appear to be worse during a dry season and on poor, impoverished soils.

Cause

Soil rot is caused by *Actinomyces ipomoeae*, an organism that lives in the soil from one season to the next. The principal source of infection is probably in the field, although it is not unlikely that infection may result from the use of infested soil in the hotbed and from infected seed sweetpotatoes.

PHYLLOSTICTA LEAF BLIGHT

Phyllosticta leaf blight is caused by a fungus (*Phyllosticta batatas*). It appears on the upper side of the leaf as roundish or angular, brownish spots one-eighth to one-half inch in diameter (fig. 12). A number of black bodies about the size of a pin point and just visible to the naked eye are scattered indiscriminately within the spots. The bodies are slightly raised and rounded in a domelike manner and contain numerous colorless spores. So far as known, the fungus is not parasitic on any other plant; nor does it occur on other parts of the plant than the leaf. It is thought to live through the winter on the dead leaves. The disease occurs every year in practically all the Southern States, but it is less common as far north as New Jersey, Delaware, Maryland, Iowa, Kansas, and Illinois.

FIGURE 12.—Section of a sweetpotato leaf showing the presence of a number of circular phyllosticta leaf blight lesions. Note the numerous black specks in which the spores are borne.

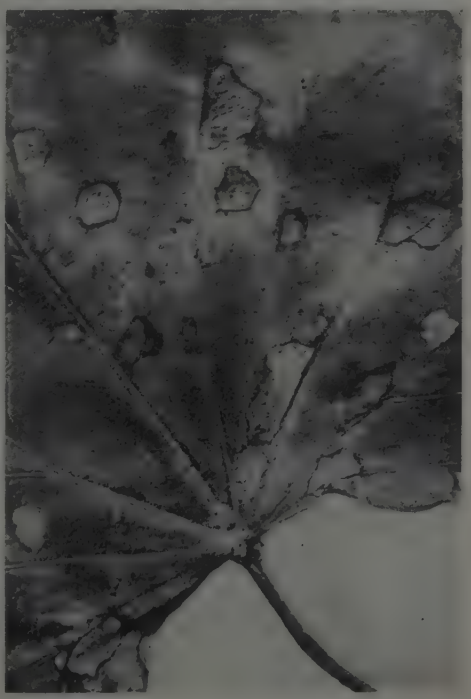

FIGURE 13.—A sweetpotato leaf showing white spots caused by the septoria leaf spot fungus.

Phyllosticta leaf blight has never been serious enough to require the application of remedial measures.

SEPTORIA LEAF SPOT

Septoria leaf spot is caused by a fungus (*Septoria bataticola*), remotely similar in general appearance to that causing leaf blight. It is characterized by circular, white spots about one-eighth inch in diameter, scattered indiscriminately over the upper surface of the foliage (fig. 13). Within these white areas one or more black specks, just visible to the naked eye, may be seen. These specks contain numerous spores, which upon escaping may be carried by insects or other agencies to other leaves, where new infections may start. Like the organism causing leaf blight, this fungus is not known to be parasitic on other species or on other parts of the sweetpotato. It probably overwinters on the dead leaves in the field.

Septoria leaf spot is very widely distributed, having been collected in New Jersey, Delaware, Iowa, and other States where sweetpotatoes are grown. This disease is nowhere serious enough to require the application of remedial measures.

WHITE RUST (LEAF MOLD)

The first symptom of white rust is the loss of the green color in spots on the under side of the leaf (fig. 14). Later these spots become brown and covered with a whitish, viscid growth, which finally becomes more or less powdery. This white powdery mass is made up of numerous spores or reproductive bodies, which serve to start new infections if they fall on other leaves and conditions are favorable. No great harm results from the attack of this fungus, though it may sometimes produce swellings on the stems and petioles and cause malformations of the leaves and young shoots. White rust is widely distributed and occurs on a number of other plants, among them the wild morning-glories. This disease has never been serious enough to require remedial measures.

White rust, caused by a fungus (*Albugo ipomoeae-panduranae*), is more prevalent during wet seasons. It is prevalent on sweetpotatoes in the Tropics and commonly found in most of the Southern States. Under favorable weather conditions it occurs in New Jersey and other States along the northern border of the sweepotato belt.

FIGURE 14.—A sweetpotato leaf showing injury caused by the white rust fungus.

STORAGE ROTS AND THEIR CONTROL

SOFT ROT (RING ROT, COLLAR ROT)

Soft rot, caused by the bread mold (*Rhizopus nigricans*), is one of the most destructive diseases of sweetpotatoes in storage. The decay begins usually at one end and progresses rapidly, requiring but a few days with favorable temperatures and humidity to destroy the entire sweetpotato. Soft rot may set in soon after storage and may continue more or less throughout the storage period, depending largely upon the condition of the roots when stored and upon management of the house. At first the sweetpotatoes are soft, watery, and stringy. After decay and the escape of moisture, they gradually become firm, hard, shrunken, and brittle. Such dry sweetpotatoes are frequently referred to by the farmer as being affected with a dry rot, which in reality is a dried soft rot. If the skin is broken while it is still soft a moldy growth, sometimes referred to as whiskers, forms on the surface (fig. 15).

One sweetpotato affected by soft rot may communicate the disease to numerous others lying close to it. The spores of the black mold produced on the surface may be carried by flies or wind currents to other roots in the same house or may be communicated to them by handling. On these, new infections may take place if the temperature and moisture conditions are favorable.

The disease called ring rot is caused by the same mold (*Rhizopus nigricans*) as soft rot. It differs from soft rot in that the decay begins at a point between the two ends instead of at the ends. From the point of infection the decay forms a ring, or collar, around the sweetpotato, while at the same time it extends slowly toward the two ends. Under conditions favorable to the mold the sweetpotato may be wholly destroyed. If, on the other hand, conditions unfavorable for its

FIGURE 15.—A sweetpotato showing the moldy growth, or whiskers, of the fungus causing soft rot.

further development, such as a relatively low humidity and low temperatures exist, it may only form a ring, or collar (fig. 16), varying in width from 1 inch to 3 inches.

The losses sustained in storage from soft and ring rots amount to many hundreds of thousands of dollars annually. The causal organism is found everywhere and will grow on almost any decaying vegetable matter. It is therefore impossible to exclude it from storage houses. It generally gains an entrance to the sweetpotato through wounds and bruises made by rough handling or by rats and mice.

BLACK ROT

Black rot caused by the fungus *Ceratostomella fimbriata*, a serious disease of the plants in the hotbed and in the field (p. 7), is a storage rot as well. The loss throughout the country caused by it in storage and in the field probably equals that of all the other diseases combined.

When sweetpotatoes are dug, black rot spots are comparatively rare, but it is likely that many potatoes are infected, the point of infection being so small as to be invisible to the naked eye. In the storage house, in the presence of comparatively high temperatures and a relatively high humidity, these spots gradually enlarge, and at the end of a month or two they have formed conspicuous, somewhat round, sunken spots on the surface of the root (fig. 3). Near the center of these spots are numerous flask-shaped fruiting bodies, from which exude myriads of small spores. Although black rot generally extends only a short distance into the flesh of the roots, after several weeks' storage the causal fungus may penetrate as much as half an inch (fig. 17). Cutting

a sweetpotato crosswise through the lesion is an aid in determining whether the lesion is caused by the black rot fungus. If such is the case the flesh is black, and a bluish-black discoloration will soon develop in the tissues beneath the lesion sometimes almost to the center of the tuber.

Unlike most fungi causing rots of sweetpotatoes the black rot fungus does not need wounds to cause infection. The spores readily adhere to the bodies of insects and may be carried to other sweetpotatoes, where new infections may take place if sufficient moisture is present. The germs may also be scattered by workmen preparing potatoes for the market and by air current inside the storage house.

Sweetpotatoes should not be washed and then stored. Washing spreads the spores of the causal fungus, and infections result on other sweetpotatoes. Washing just before marketing is also a questionable practice. Some farmers and shippers have had disastrous results from washing, as black rot caused total loss of the roots treated. Even when the washed sweetpotatoes are marketed before damage results, they may be rotted before the consumer has time to use them.

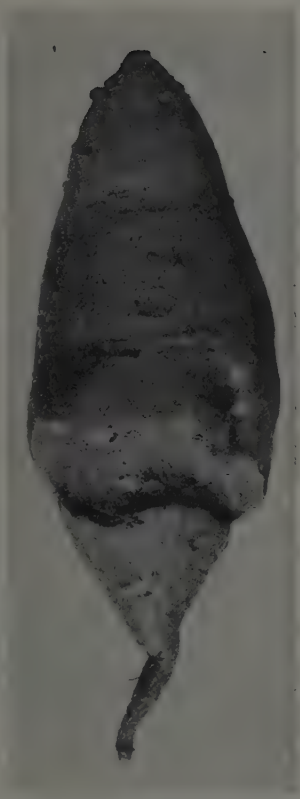

FIGURE 16.—A sweetpotato showing ring rot, frequently found in storage houses.

FIGURE 17.—Cross section through a sweetpotato with black rot lesion showing depth of penetration by the black rot fungus.

SURFACE ROT

Surface rot is characterized in the early stages by nearly circular spots (fig. 18) on the surface of the sweetpotato; these vary in number and differ in size according to the length of time that has elapsed since the infection started. The rot is shallow, seldom extending more than one-fourth to one-half inch below the surface. The sweetpotato shrinks later, especially at the margin of the spot. Finally it becomes dry and mummified.

FIGURE 18.—A sweetpotato after several weeks in storage that showed a number of more or less circular lesions associated with surface rot. The infection occurred in the field at about the time the sweetpotato was dug.

Surface rot has some characteristics in common with black rot. Surface rot spots are usually small but they may become an inch in diameter and grayish brown in color; black rot spots are nearly black and may reach a diameter of more than 2 inches. The spots of surface rot are less irregular in shape and less variable in size than those caused by bruises.

Infection takes place at the base of the small rootlets at about digging time, especially if the ground is somewhat wet, or early in the storage period. These infected areas gradually enlarge in storage and become more or less conspicuous in 6 to 8 weeks. If the storage house is kept rather warm and dry, moisture gradually escapes from the sweetpotatoes, which eventually become dry and hard.

The loss from surface rot is sometimes more than that of any other storage disease. Sometimes the sweetpotatoes are so badly shrunken that they have no market value. Some varieties shrink more than others. Some strains of the Jersey types, especially some of those with dark-yellow skin, are very little subject to surface rot. Light-skinned Jersey types, on the other hand, are more susceptible. There are no immune varieties.

Surface rot is caused by a fungus (*Fusarium oxysporum*). It is widely distributed, specimens of the trouble having been collected in all parts of the United States where sweetpotatoes have been kept in storage.

DRY ROT

Dry rot is another form of decay which generally begins at the end of the sweetpotato, producing a firm brown rot. The causal organism grows slowly, and finally the sweetpotato becomes dry, hard, and mummified (fig. 19). Small domelike or pimplelike protuberances just visible to the naked eye finally cover the entire surface. If the skin is scraped slightly, the tissue beneath presents a coal-black, carbonaceous appearance. Several weeks are required under normal conditions for this organism to destroy a sweetpotato completely.

Dry rot is caused by a fungus (*Diaporthe batatatis*). In the little domelike protuberances (fig. 19) myriads of colorless spores which serve to reproduce the fungus are found. The dry rot fungus grows on the stems and vines above ground under field conditions, and probably sweetpotatoes become infected in the field. Dry rot has also been found on the stems of young plants in hotbeds.

FIGURE 19.—A sweetpotato showing the characteristic appearance of dry rot. On the surface are domelike protuberances containing myriads of colorless spores which serve to reproduce the fungus.

FIGURE 20.—A sweetpotato showing the dry, mummified condition produced by the Java black rot fungus. Note the numerous pimplelike protuberances containing spores borne beneath the surface.

Dry rot, which is widely distributed throughout the country, is frequently found, but it can in no sense be regarded as one of the more serious storage troubles.

JAVA BLACK ROT

Java black rot, so called because its discovery on sweetpotatoes grown from an importation from Java, suggested that the disease might have been introduced from that country, is widely distributed in storage houses. It is more prevalent in the South than elsewhere.

The disease, caused by a fungus (*Diplodia tubericola*), is strictly a storage trouble. It slowly makes the sweetpotatoes dry, hard, brittle, coal black within, and difficult to break (fig. 20). It is reproduced by spores borne in more or less flask-shaped receptacles beneath the surface. When the surface of the root is broken, these spore bodies are set free. Java black rot begins usually at the end and progresses very slowly, requiring under normal storage conditions from 4 to 8 weeks to destroy a sweetpotato completely.

CHARCOAL ROT

Charcoal rot, found in the storage houses throughout the country, likewise is characterized by a black decay of the roots. This rot differs from others of a similar appearance by the production of minute spherical resting bodies throughout the interior of the sweetpotato, rarely on the surface. These bodies are coal black. If the skin of the sweetpotato is removed, they can be seen with the naked eye buried in the tissue. Some shrinking and drying of the sweetpotato follow an invasion of this fungus, and the fleshy root may become a hard, dry, charcoallike mummy. The total loss to the crop that might be attributed to this disease is comparatively small. The rot is caused by a fungus (*Sclerotium bataticola*). It is more prevalent in the Southern States than elsewhere.

CONTROL OF STORAGE ROTS

The inability of farmers to keep sweetpotatoes sound in storage is a great handicap. The first step is the control of field diseases, many of which spread during storage or afford avenues of entry for decay-producing organisms, so that disease-free sweetpotatoes are available for storage. As most decay-producing organisms cannot attack sound, unwounded sweetpotatoes the roots should be handled carefully to avoid bruises and should be protected from wounds such as those made by rats and mice. To allow healing of wounds and broken ends, the sweetpotatoes should be cured for 10 to 14 days at a temperature of 80° to 85° F. and a relative humidity of 85 to 90 percent. During the subsequent storage period the temperature should be 50° to 55° and the relative humidity 80 to 85 percent.

Sweetpotatoes handled in crates keep better than those in piles, as sweetpotatoes will not stand frequent handling. It is unwise to disturb a pile or a bin unless all are to be marketed.

DIGGING AND HANDLING SWEETPOTATOES

Sweetpotatoes intended for storage should be dug as late in the fall as is consistent with weather conditions. This is usually just before frost. Frozen sweetpotatoes will not keep well, and it is likely that a heavy frost will injure them to some extent. It is advisable, too, after a heavy frost to cut the vines at once and dig the roots. It is believed that warm, dry, sunny weather before a frost is better for all concerned than a period a little late in the season after a frost. To wait too long may mean that in order to avoid freezes the roots must be dug during bad weather. After the sweetpotatoes are dug, they should be allowed to dry as long in the sun as weather conditions and farm operations will permit. On a very hot day, however, it would be desirable to hurry them to the shade after their surfaces have been dried in the sun.

Although sweetpotatoes sometimes keep well when stored in banks with hay and earth thrown over them, this system is not as reliable as a storage house. For full details on storing and marketing, the reader is referred to Farmers' Bulletin 1442, Storage of Sweetpotatoes. During the digging period and for 10 days thereafter the temperature of the house should be maintained at about 80° to 85° F. and a relative humidity of 85 to 90 percent to promote healing and reduce shrinkage. The ventilators should be kept closed except when it is necessary to prevent condensation of moisture. If the temperature is properly controlled there is little danger of the humidity being too high during the curing period. After about 2 weeks at 80° to 85° the temperature should be lowered gradually to about 50° to 55° and maintained there through the storage period. During the winter the temperature and moisture of the house should be watched.

The humidity should be kept at 80 to 85 percent. If the walls, ceilings, and sweetpotatoes become wet it may be necessary to open the ventilators to remove the excessively moist air, but they should be closed before the humidity is reduced too much.

In the fall, shortly before the sweetpotatoes are put into storage, all the dirt and rubbish of the previous year should be swept out and the walls and floor of the storage house or cellar thoroughly cleaned and treated by some method that will destroy the germs that are left in it. Any one of several methods may be employed. One simple and practical method is to coat the walls, bins, and floor thoroughly with whitewash; or the house may be sprayed inside with a solution made by dissolving 1 pound of copper sulfate in 25 gallons of water. After 1 or 2 days the application should be repeated. Similar results can be obtained by fumigating with a gas generated by formaldehyde and potassium permanganate. Three pints of commercial formaldehyde and 23 ounces of potassium permanganate should be used for each 1,000 cubic feet of storage house. Several containers (buckets, crockery, or large cans), depending on the size of the house, should be placed in it and the required amount of potassium permanganate divided among them. The formaldehyde should be set beside the containers.

Gloves and goggles should be worn to protect the hands and eyes in case of accident. Beginning with the container farthest from the door, pour the formaldehyde on the crystals and proceed rapidly to the next container. After finishing with the container nearest the door quickly leave the house and close the door. The gas generated by the mixture of the two chemicals is very irritating to the eyes. Keep the house closed at least 24 hours, then open, and ventilate thoroughly.

Another effective method is to fumigate by burning for 24 hours ¾ to 1 pound of ordinary flowers of sulfur to each 1,000 cubic feet of space. Metal containers set on a base of brick to raise them off the floor should be used in order to avoid the danger of fire. Do not use containers with soldered parts. Distribute the required amount of sulfur in each container and then set it afire and immediately leave the house and close the door. The effectiveness of the fumigation with

sulfur or formaldehyde is increased if the inside of the house is lightly sprinkled or sprayed with water about 2 days before applying the treatment. The crates also should be disinfected by one of the methods just described.

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